comitant labours) as in itself comprising archæology. This cannot be; the excavator supplies the materials, and it rests with him to supply them in a scientific and workmanlike manner; but the years of study which they often demand must be the lot of the student, who, we can assure our author, would often be only too grateful if he had the chance of combining both functions.

The subject is distributed over fourteen chapters, beginning with the qualifications of the excavator himself, the experience or instinct necessary for identifying sites or finds, and three chapters dealing with the actual work in the field—the labourers, methods of turning and raising earth, and recording on the spot. Then follow successive chapters on copying and drawing, photography, preservation of objects, packing, and finally publication. The last four are of a more general nature, dealing with the systematising of results, the nature of archæological evidence, the ethics of archæology, such as the rights of the State, and lastly, the fascination of history by way of epilogue. Space forbids a detailed description of the many interesting points and valuable suggestions contained in these chapters, but the book will be found eminently readable even by those who cannot hope to wield the spade.

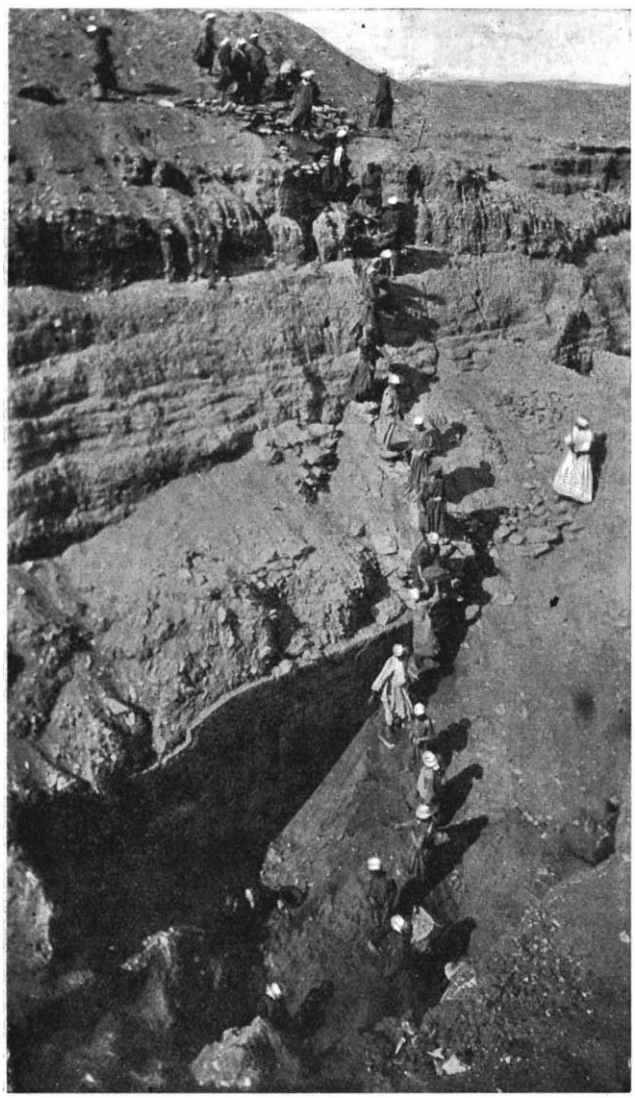

FIG. 1.—The clearing of the Osireion at Abydos, Egypt.

We cannot, however, lay it down without a feeling that the author is throughout too prone to disregard the work of other archæologists; for instance, on p. 123, where he complains that no one since Montfaucon (whose work, by the bye, is singularly useless) has attempted the collecting of series of objects in a *corpus*. Has he never heard of M. Reinach's invaluable *répertoires* of Greek sculpture and vases? Is he not aware that the German Archæological Institute is issuing a magnificent publication of Greek terracottas? And is not a *corpus* of coins under consideration? We purposely pass over the growing number of museum catalogues of all kinds, which if not *corpora*, are still a step in that direction.

The book is illustrated by sixty-six photographic or outline reproductions, of sites, operations, and monuments, the titles of which are at times somewhat oddly arranged (*e.g.* Figs. 36–37), but they are clear, well chosen, and instructive. We have selected for reproduction the frontispiece, representing the clearing of the Osireion at Abydos by a chain of boys with baskets, extending more than forty feet down. The index errs if anything on the side of redundancy; such headings as "carefulness, means of securing"; "chain of boys"; "choice of facts"; "finest lines in drawing"; "list of plates"; "red paint"; "wet squeezes," are not only superfluous, but contrary to all the rules of good indexing. H. B. W.

PROF. A. W. WILLIAMSON, F.R.S.

ON Friday last, May 6, there passed away, full of years and of honour, Alexander William Williamson, one of the most notable of British chemists, and one who, in the heyday of his intellectual activity, exercised a remarkable influence on the development of chemical theory. He had been in failing health for some years past, and such was the seclusion in which he lived of late that his tall manly form and striking features were practically unknown to the younger generation of chemical workers. Indeed, after his retirement, in 1889, from the position of Foreign Secretary of the Royal Society, which he held for some sixteen years, and after the termination of his active connection with the British Association for the Advancement of Science, of which he was treasurer for many years, he rarely visited London, and unless on an occasion when it was represented to him that his influence and the weight of his authority were needed in support of some reform, it was difficult to induce him to revisit the scenes of scientific activity in which he had himself played so strenuous and so eminent a part. Until within the last few years, when his mental powers were obviously failing, he continued to take a keen interest in the progress of science, and it was easy to engage his attention on the broad general lines of its development.

Williamson's mind was cast in a large mould, and, although at times he could occupy himself with even small details if he recognised that these were significant or possibly fruitful of theoretical consequence, he was apt to be impatient of the somewhat tiresome minutiæ with which modern chemical literature abounds. He was probably never a great reader of such literature at any period of his career, and his

physical infirmity made it increasingly difficult for him to keep himself informed. At the same time the very limitation of his physical powers, his partial paralysis, and his poor eyesight, probably conduced to his eminence as a speculative thinker. He was gifted with a strong logical mind, and was an acute reasoner, and a clear, vigorous, and independent thinker, capable of broad and striking generalisation. Knowledge, we know, dwells in heads replete with thoughts of other men, wisdom in minds attentive to their own. Except by personal contact, Williamson was largely debarred from the knowledge of other men's thoughts; by the very circumstances to which allusion has been made he became more attentive to his own. Like most original thinkers he was somewhat tenacious of opinions, and apt to be dogmatic in their utterance. His beliefs were too hardly won to be lightly discarded. But although at times impatient of contradiction, he had too strong a regard for truth, was too sincere and broad-minded a man to persist in any opinion, if its unreasonableness was made clear to him. Like Carlyle, his philosophy was largely swayed by his emotions, and like Carlyle's, his judgments on men and things were apt to be tinctured by the mood of the moment—a fact which may serve to account for seeming inconsistencies in their expression.

He had a high sense of duty, and of the responsibilities of his position as a representative man of science. Although, like many strong men, fond of power, he was in no sense a self-seeking man, and was contemptuous of the artifices by which smaller and more ambitious men seek to gain preferment.

Williamson was born at Wandsworth on May 1, 1824; hence he had just completed his eightieth year at the time of his death. Much of his early life was spent on the Continent. He began the study of chemistry under Gmelin at Heidelberg, in the old cloisters which formerly did duty as class rooms and laboratory, but soon joined Liebig at Giessen. Whilst at Giessen he published, so far back as 1845, his first paper on "The Decomposition of Oxides and Salts by Chlorine," in which he determined the conditions of production of hypochlorous and chloric acids, and the cause of the difference in the mode of action of chlorine upon alkalis and alkaline earths, and upon salts. The main outcome of this paper has long since been worked into the text-books. It is of interest as throwing light upon the theory of the action of bleaching solutions. The experimental material for a short paper on "Ozone" was likewise accumulated at Giessen. In this paper, which also appeared in 1845, Williamson concluded that the peculiar properties belonging to the oxygen set free by the agency of the electric current are produced by the admixture of a *peroxide or acid of hydrogen,* whereas by the action of phosphorus on atmospheric air the same substance is *not* produced. His surmise that a compound of hydrogen and oxygen existed possessing some of the characteristic properties of ozone but dissimilar from Thénard's hydrogen peroxide has not been established by subsequent investigation.

At about this time Williamson took his degree, and in 1846, whilst still at Giessen, published an important paper on "The Blue Compounds of Cyanogen and Iron," which probably contains more determinative analytical work than any other of his memoirs. In it he describes the formation of prussian blue in different circumstances, and the influence which these exercise on its composition, giving particular attention to the presence of potassium, which materially affects the colour and dyeing power of the product.

These, with two short papers, one relating to the theory of ozone, and another on the constitution of œnanthol, which he published in Liebig's *Annalen,* comprise the outcome of the Giessen period. He then passed on to Paris, where he came under the influence of Comte. It is hardly to be supposed that a man of his temperament, and in such surroundings, could remain wholly unaffected by the events of 1848. His position, however, was made secure by Graham, who came over to Paris to offer him the chair of practical chemistry in University College, to which he was appointed in 1849, and where he continued to teach for thirty-eight years.

In 1850 Williamson published his epoch-making paper on the "Theory of Ætherification." It was first read to the chemical section of the British Association at the Edinburgh meeting of August, 1850, and in its original form as "communicated by the author" occupies about seven pages of the *Philosophical Magazine.* Certainly no chemical paper of equal length ever exercised so profound an influence on contemporary thought. This memoir, although frequently referred to, is probably seldom read by the chemical student. And yet written more than half a century ago there is scarcely a term in it which needs alteration to bring it into harmony with modern chemical terminology or present day doctrine. It is a model of concise reasoning, founded upon happily devised experiment. Williamson clearly traces for us the genesis of the idea which led him to his capital discovery. His original intention was not to elucidate the theory of the manufacture of ether; he says his object in commencing his experiments was to obtain new alcohols by substituting carburetted hydrogen for hydrogen in a known alcohol, and for this purpose he acted upon sodium ethylate with the iodide of the carburetted hydrogen which was to be introduced in the place of that hydrogen—an expedient which he says he hopes may render valuable services on similar occasions. To his astonishment the compound thus formed had none of the properties of an alcohol—it was nothing else than common ether, $C_4H_{10}O$. This simple observation threw a flood of light upon the relations of alcohol and ether, which Williamson proceeded to develop by a train of reasoning, and to prove by a series of experiments which are now among the commonplace observations of every lecturer in organic chemistry wherever the science is taught. Williamson not only illustrated these relations by arguments and proofs which are absolutely unassailable, but by a course of reasoning which instantly riveted the attention and secured the adhesion of the whole chemical world, he demonstrated the true process of etherification, and thereby reconciled the teaching of apparently irreconcilable facts. It must have been with a special gratification that the young man of twenty-six penned the following lines, which happily summarise the position he had attained.

"Innovations in science frequently gain ground *only* by displacing the conceptions which preceded them, and which served more or less directly as their foundation; but, if the view which I have here presented be considered a step in our understanding of the subject, I must beg leave to disclaim for it the title of innovation; for my conclusion consists in establishing the connection and showing the compatibility of views which have hitherto been considered contrary; and the best possible justification of the eminent philosophers who advocated either one of the two contending theories, is thus afforded by my reconciling their arguments with those of their equally illustrious opponents." An observation no less tactful than true.

The paper is epoch-making in more senses than one. In it Williamson not only foreshadowed his adherence to the doctrine of types which in his subsequent teaching he did so much to elucidate and extend, but he

likewise seeks to import into the general process of chemical action the conceptions of dynamics. The simple words with which he concludes his paper sound somewhat archaic to-day, but fifty-four years ago they must have startled the members of Section B. "In using the atomic theory, chemists have added to it of late years an unsafe, and as I think, an unwarrantable hypothesis, namely that the atoms are in a state of rest. Now this hypothesis I discard, and reason upon the broader basis of atomic motion."

Williamson was not a prolific writer, and his fame mainly rests upon his work of this period and upon what he achieved during the first ten years of his professorial activity. He published comparatively little between 1854 and 1864, but under the stimulus of the new movement, he took an active part in the formulation of what is still current doctrine, and produced a series of papers on the principles of chemical classification, valency, and nomenclature which exercised a powerful influence on chemical teaching in this country.

Williamson was elected into the Royal Society in 1855, and served on the council from 1859 to 1861, again from 1869 to 1871, and for a third time from 1873 to 1890, during which period he acted, as already stated, as foreign secretary. In 1889–1890 he was made a vice-president. In 1862 he received a Royal medal. He was twice president of the Chemical Society—viz., in 1863–65 and again in 1869–71, and was one of the six presidents who had been fellows of the Society for upwards of half a century who were present at the memorable banquet in 1898. He was largely instrumental in establishing the present series of abstracts of foreign chemical literature which form so valuable a feature of the *Journal* of the Chemical Society.

In 1873 he was president of the British Association.

His merits as a man of science received wide-spread recognition. He was an honorary graduate of Dublin, Edinburgh, and Durham, a member of the Institute of France and of the Berlin Academy, and of many scientific societies on the Continent and in America.

T. E. THORPE.

ÉMILE DUCLAUX.

IN the death of Émile Duclaux science has lost one of her most devoted and brilliant workers. His career has formed the principal link between the bacteriology of the present day, and what may be called the heroic period in the history of micro-biology which followed on the unveiling, by the genius of Pasteur, of the secret of fermentation, and the consequent opening out of avenues through which innumerable problems could be successfully attacked.

The Pasteur Institute will in particular mourn its loss, for, owing to the charm of his personality and the extraordinary catholicity of his scientific enthusiasms, he was a worthy successor to the great leader, and the continuance of that brotherliness which was such a striking feature among the little community of scientific investigators in the Rue Dutot must in considerable measure be attributed to his influence.

Duclaux was born at Aurillac, on June 24, 1840. He was not a son of fortune, and it was only by dint of hard struggle and a determination which was capable of much self-denial that he succeeded in becoming a *Normalien* in 1859. At the Ecole Normale he studied principally chemistry and physics, and left the school as *Agrégé* in 1862.

At that time Pasteur, who had returned to the Ecole Normale as director of scientific studies, had recently established the positions of Agrégés préparateurs, whereby an able and earnest young graduate might remain for a few years as a research-assistant to one of his masters.

For some three years Duclaux remained préparateur to Pasteur, and was his first lieutenant during the celebrated investigations into the causes of diseases in wine and into the silkworm disease, which had nearly ruined some of the Departments of France.

In 1865 he became Docteur ès Sciences, presenting a thesis upon fractional distillation. In the same year he was appointed a professor at the *lycée* in Tours, and during the following year became acting professor of chemistry at Clermont. It was at Clermont that Pasteur stayed with Duclaux during the troublous times of the war, and it was here that the intimacy and affection which ceased only at the death of Pasteur was established between them. It was at Clermont, also, that he numbered among his students Roux, whom he introduced to Pasteur.

From Clermont, Duclaux went to Lyons as professor of physics, where he remained until he accepted, in 1878, the chair of physics and meteorology at the Institute Agronomique in Paris. In 1886 he became professor of biological chemistry at the Sorbonne, which position he held until his death. When the Pasteur Institute was completed, he transferred his classes to the Rue Dutot. At the death of Pasteur, Duclaux was elected to succeed him as director, and for the last nine years the great work of the Institute has been developed under his guidance. He, however, has not taken any direct part in that portion of its activities dealing with infective diseases, but has confined himself more particularly to the chemical and industrial side of microbiology.

When one considers the scientific work of Duclaux, the first and most striking point is the wide range of subjects it includes. Trained as a chemist and physicist, he has occupied chairs in both these subjects, and has published a not inconsiderable number of original researches in the domains of pure chemistry and physics. At the same time his most important work was biological. Like Pasteur, he was a chemist who worked at biology, but principally at that department of biology dealing with the physiology of micro-organisms and the chemistry of enzymes, and he brought his training in the exact sciences to bear upon investigations of a biological character, with the greatest success.

The list of his original contributions to scientific journals contains upwards of eighty papers, and includes papers on molecular physics, chemistry, meteorology, physiology of digestion, enzymes, vegetable physiology, bacteriology, and technological papers on milk, butter, wine, sericulture; and he is also the author of several books. In "Ferments et Maladie" and "Le Microbe et la Maladie" he gave popular expositions of the results achieved by the Pasteurian method, and the complete change thereby produced in the standpoint from which infectious diseases were regarded.

In 1896, Duclaux published his "Pasteur, Histoire d'un Esprit," which deals with the researches of the great master from first to last, pointing out the condition of knowledge on the various subjects before Pasteur had brought them, one by one, under the influence of his imagination and accurate experimentation. This forms one of the most brilliant descriptions of the operation of scientific method in unravelling the relationship of phenomena; its perusal might well form a portion of the education of every student of science.

The most important of Duclaux's published books is the "Traité de Microbiologie"—the four volumes of which appeared during the years 1898 to 1901—each chapter of which bears the stamp of the author's individuality, and contains many original observations not